# GEOTECHNICAL CHARACTERIZATION OF THE SUBSURFACE MATERIALS IN PAIKO AREA, NIGER STATE, NIGERIA.

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## Abstract

A geophysical investigation into the structural features of the subsoil of part of Minna topographic map sheet 42 was carried out, aiming at identifying suitable areas for raising high structures, Engineering works, road constructions and proper site for sewage disposal. Schlumberger Array, which is one of the Electrical resistivity method was employed to carry out this survey. Paiko Area, lies within the pre-cambrian. Basement complex of Northern Nigeria, with a total land mass of about 629km$^2$. About 144 Vertical Electrical Sounding (VES) points were occupied on 12 grid profiles at 2km intervals. From the results of the survey, some Iso-resistivity maps were produced from the interpretation of the sounding curves. About four(4) categories of lithologies were arrived at. Lateratic materials dominate the entire surface area with dark loaming soil and clay in some part of the area. The low resistivity basement sections and the high resistivity basement sections were located and found at different region from the maps. Areas with abundance of clay deposited, which are used by the brick industry was identified. The area under study is virtually suitable for high structures, sewage disposal, construction of roads and other human activities as the topic suggest. I therefore recommend further survey with different methods in the area. To burst the economic activities in the area, Federal/ state Government, local government as well as business men and women could engage the area for business purposes.

## Introduction

Although Paiko Area which is part of the Minna topographic map has experienced so many surveys in the past, either by company such as Ruwatan, Water Board or individuals in the past. But the main focus of those surveys were purely on spot points for Borehole drilling and so does not bring into focus the kinds of features expected like the ones we are going to witness by this investigation. Paiko being the headquarters of Paiko Local Government Area, having boundary with Chanchaga and Suleja Local Government Area at the Western and Eastern part of Niger States experiencing a lot of development in various forms. Because of these changes, information about the lithology of the area is of paramount importance. Paiko is a commercial center for yam buyers and growers and the population is increasing at arithmetic progression because of the influence of people from various part of the country, especially farmers and traders. This work is at present the first of its kind and its going to have positive impacked in the area.

## Physiography and Geology

The area in question lies within the basement complex of Northern Nigeria. The theories of the geology of the basement complex rocks of Nigeria has been exhaustively discussed in works like those of McCurry, (1975), Van Breewan, et al, (1987) etc. The area is fairly undulating with expanses of plain lands especially in the eastern part of the study area and characterized by very high step sided hills in the western part of Paiko town. The area is underlain by igneous rocks of the Northern Nigeria basement complex in the region.Further more, the geology of the study area falls within the basement complex of Nigerian (fig 1.1).

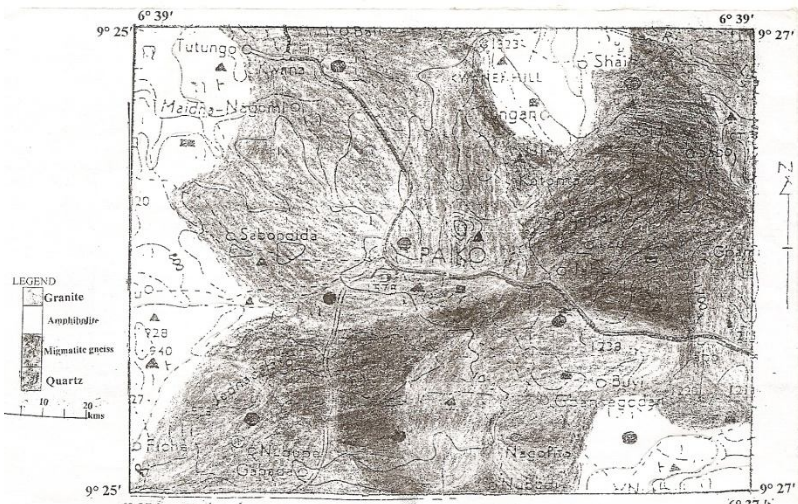


Fig 1.1: Geological Map of the study area.

Minna sheet 42

The area is, therefore underlain by four lithological formation as is evident from the rocks in the area. The rock types in the region includes; granites, gneisses, quartzites as well as laterites while most of the granites seen here are older granites and this distinguish them from the younger granites found in Jos area.

According to (Ali, et al, 1993), the area belongs to kibaran orogeny and the rocks range in age from 450Ma to 750Ma. It is located on longitude $9^{0}25^{1}$E and $9^{0}27^{1}$E and latitude $6^{0}37^{1}$N & $6^{1}39^{N}$ on the landmass of 629km$^{2}$.

## Method

The method employed for this geophysical survey, was the electrical resistivity, using the Schlumberger 4-electrode. The theories behind this method are well spilt out in standard text books such as koefoed, (1989), Keller, et al (1966) and Telford, et al (1976).

In using Schlumberger configuration in depth probing, the general tradition is that, the potential electrodes are fixed while the current electrodes spacing are expanded symmetrically about the center of the spread. It is obvious that the smallest current-potential electrode distance is always considerably greater than the distance between the two potential electrodes from the first principle, the apparent resistivity ($\rho_a$) is given by

$$\rho_a = \frac{2\pi \Delta V}{I}$$

The sounding was carried out in 12 profiles at 2km interval, in order to cover the all area and about 144 sounding stations were arrived at (fig 1.2).

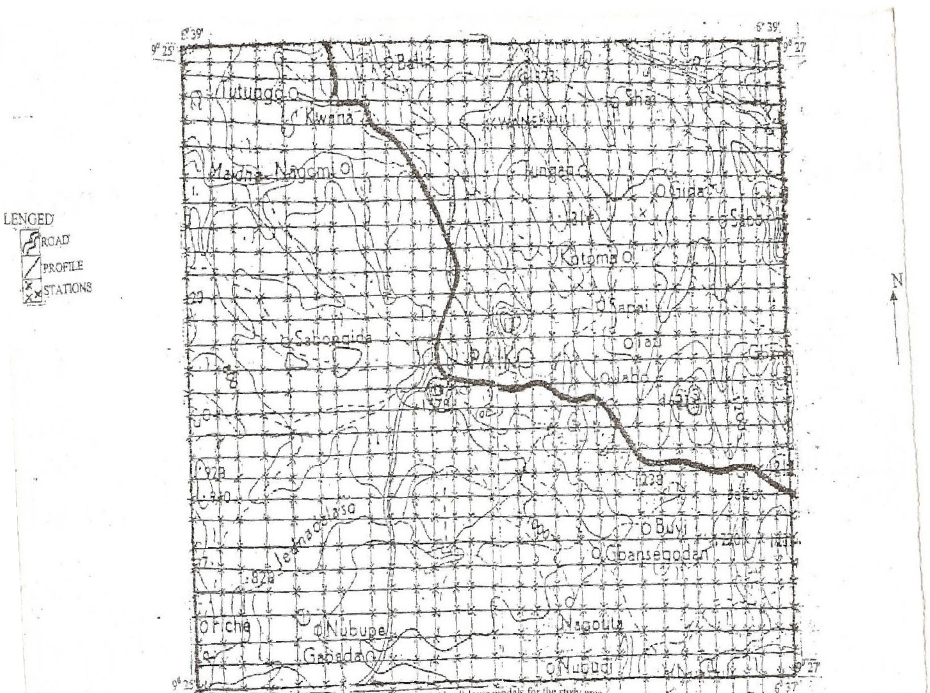


Fig 1.2 : True Resistivity (digitized) layer models for the study area

Each profile runs North-South and are perpendicular to the express road running from Minna – Suleja, until the all field is covered.

A maximum of AB 200m and MN30m were occupied for effective probe of the basement layers, Terrameter SAS 300 D.C was used for the data acquisition and the grid station were located using wooden pegs marked with red paints.

**Results**

A quantitative interpretation of the data collected were carried out using the new iterative method developed by Zohdy, (1989). This method gives us directly the number of layers, their thickness, or resistivity values. A typical digitized and interpreted curves are shown in (fig. 1.3).

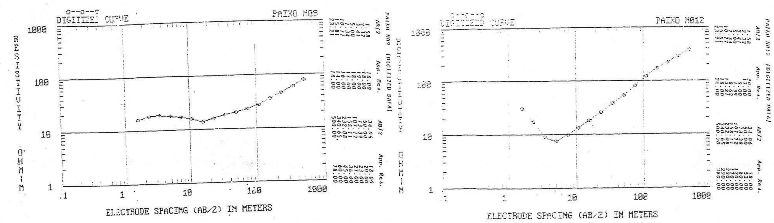


Fig.1.3 a typical digitized curve

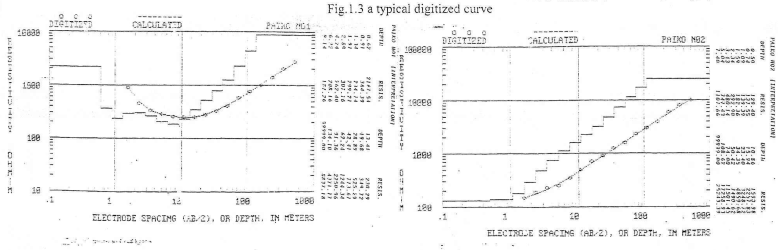


Fig.1.3 b interpreted curve

Thus the layers, their depth, thickness and resistivity values for each of the sounding points were evaluated. From the information available, maps of the area were produced. These includes the iso-resistivity maps at various depth and the resistivity map of the all area.

**Discussion of Results**

**Resistivity Map**

This map was produced using a contour interval of 100Ω-m, this is found on

(fig 1.4).

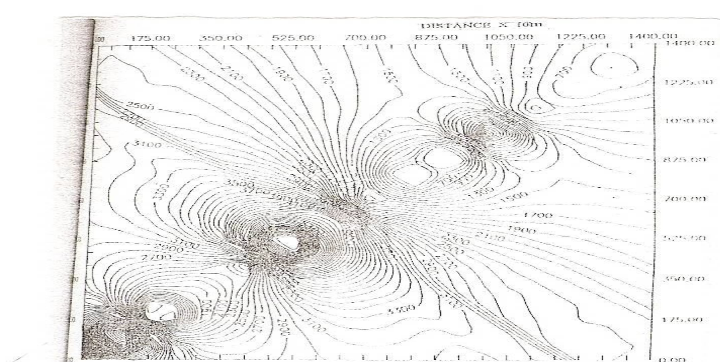


Fig 1.4: Resistivity Map of the study area, contour interval 100Ωm

The area is surrounded by mountains giving the area in questions a valley-like structure. The resistivity generally ranges between 600Ω-m to 7600Ω-

m. The lowest resistivity is about 600Ω-m found at the north eastern part of the map, this continue to increase outward to about 2300Ω-m, towards the north-western part of the map. The highest resistivity found on the map is about 7600Ω-m is located at the mid-central part of the contour map. One prominent feature of the map is the nature of the contour lines cutting across from the north-western part to the south-eastern part. This features actually shows the strength and how suitable the area will be for any super structures and suitable for sewage disposal.

**Iso-resistivity Maps**

The Iso-resistivity contour map found on (fig 1.5) was at 10m depth. It has contour interval of 20Ω-m. The highest resistivity was found at the western part of the map and the lowest resistivity at the northern part. The highest resistivity is found to be 200Ω-m and lowest resistivity was 40Ω-m. The Iso-resistivity map (fig 1.6) was at a depth of 20m, with contour interval of 10Ω-m. The highest resistivity value is found at the mid-south western part of the map, which is about 500Ω-m and the lowest resistivity is found around north-eastern part of the contour map, which is about 40Ω-m. The Iso-resistivity contour map (fig 1.7) was at the depth of 30m, it contour interval is 20Ω-m. The lowest resistivity is found at the mid-south western part, which was about 560Ω-m and the highest resistivity is about 800Ω-m found at the south-western part of the map. The Iso-resistivity map (fig 1.8) was at the depth of 40m, with contour interval of 50Ω-m. The highest resistivity value was noticed around mid-south western part of the map, which was about 2,250Ω-m and the lowest resistivity was around north-eastern part of the map, with resistivity of 200Ω-m. Generally, the geological features established from the resistivity values of various rocks as given by Telford, et al (1976), parasnis, (1986) and Van Breewen (1981), revealed clay, sand, granite and coarse sand, and these are in lined with the four lithological formations from the interpreted curves.

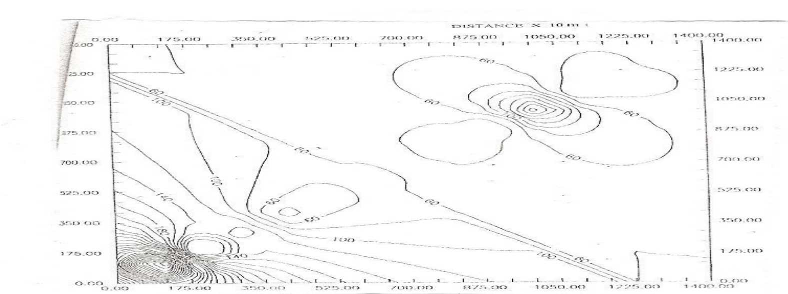

Fig 1.5: Iso-Resistivity Contour Map at 10m depth

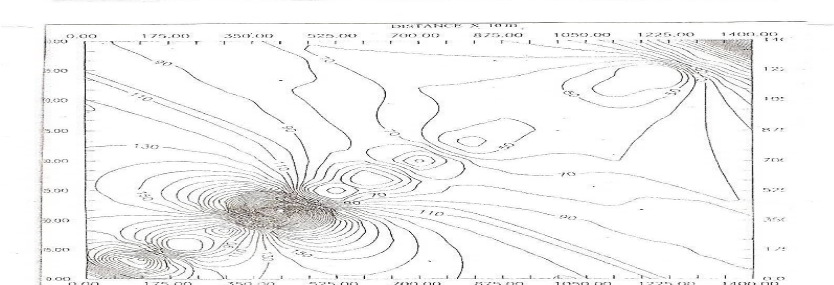

Fig 1.6: Iso-Resistivity Contour Map at 70m depth

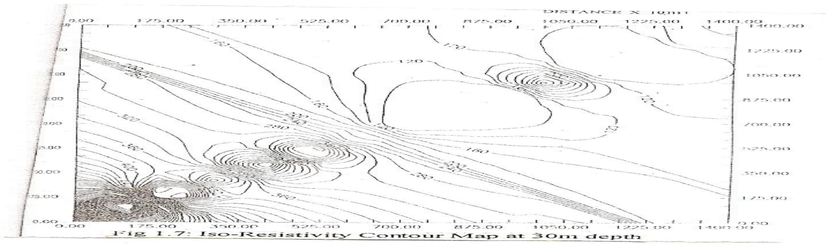

Fig 1.7: Iso-Resistivity Contour Map at 30m depth

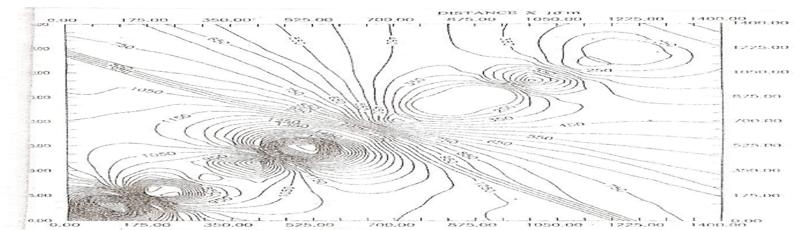

Fig 1.8: Iso-Resistivity Contour Map at 40m depth

**References**


Ali, S., Shamans, E.N & Likkason O.K (1993). The basement structure in Barkumbo Valley, Bauchi, Nigeria. A revelation from seismic refraction and D.C Resistivity studies. *journal of Minna and Geology*. Vol. 29(2). Pp 47-51.

Keller, G.F. & Frischnechi, F. (1966). Electrical method in Geophysical prospecting program press Inc. New York.

Koefoed, O. (1989). Geosounding principles, Resistivity sounding measurement, methods in Geochemistry and Geophysics, Elsevier Science publications, Pp 278.

McCurry, P. (1975). The geology of the Pre-cambrain to lower palazoic rocks of Northern Nigeria. Geology of Nigeria, Edited by C.A Kogbe. Pp 56-67.

Parasnis, D.S (1986). Principles of applied geophysics (4$^{th}$ Ed.,) Chapman and Hall, New York.

Telford, W.M., Geldert, L.P., Sheriff, R.E & Keys, D.A (1976). Applied geophysics, Cambridge University Press.

Van-Breewen, R.A. (1981). A cambining of electrical resistivity, Seismic refraction and gravity measurement for ground water exploration in Sudan. Geophysics, 46, N0. Pp1304-1311.

Zohdy, A.A.R. (1989). A new method for the automatic interpretation of schlumberger and Wenner sounding curves, Geophysics. Vol. 54, N0. 2, Pp245-253.